

Advanced Solid State Lighting for Human Evaluation Project

Center Independent Research & Developments: KSC IRAD Program | Science Mission Directorate (SMD)



ABSTRACT

Lighting intensity and color have a significant impact on human circadian rhythms. Advanced solid state lighting was developed for the Advanced Exploration System (AES) Deep Space Habitat (DSH) concept demonstrator. The latest generation of assemblies using the latest commercially available LED lights were designed for use in the Bigelow Aerospace Environmental Control and Life Support System (ECLSS) simulator and the University of Hawaii's Hawaii Space Exploration Analog and Simulation (Hi-SEAS) habitat. Agreements with both these organizations will allow the government to receive feedback on the lights and lighting algorithms from long term human interaction.

ANTICIPATED BENEFITS

To NASA funded missions:

Lighting and active lighting regimes can assist in overcoming crew sleep disorders and help with shifting crew circadian rhythms as needed.

To NASA unfunded & planned missions:

Deep space habitation will require a well regulated circadian schedule through healthy sleep habits and patterns.

To other government agencies:

Any government agency with shift workers can benefit from this technology. Cool, bright light will help concentration and gradual changes can enable those same workers to transition to their rest period easier.

To the commercial space industry:

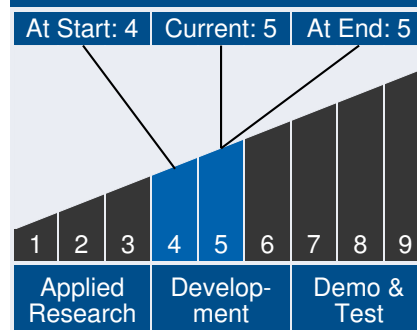
All long term space human habitation will benefit from regulated



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Technology Maturity



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circadian rhythm systems.

To the nation:

Sleep is an important health issue. This work can help address sleep disorders without using painful and/or inconvenient light boxes and resorting to potentially habit forming medication.

DETAILED DESCRIPTION

Sleep has a significant impact on the human circadian rhythm. Bright light and blue light suppress the amount of melatonin, a sleep hormone, in the human organism. The latest generation of advanced solid state lighting combines characteristics of normal terrestrial diurnal illumination with that of a normal crew day as scheduled by the AES DSH program. Lighting goes from a twilight/nightlight mode and brightens as the crew goes through it's morning awakening activities. The light becomes gradually brighter and cooler as crew approaches the nominal work day, maximum brightness peaking at a color temperature of 5500K. As the work day comes to a close, and crew moves into their post work/social/rest period the light slightly dims and significantly warms approaching a color temperature of 3000K. (Cool light corresponds to a greater color temperature and warmer light to a lower color temperature.) When the crew prepares for the sleep cycle part of the day, the light dims yet to a twilight/nightlight state.

The current lights are fully addressable and reprogrammable through a USB interface, allowing medical personnel to adjust each individual light to the needs of each crew members sleep needs. Lighting can be gradually adjusted to assist with shifting crew circadian rhythm. In the event on one member of the crew experiencing a sleep disorder, lights can be adjusted to assist with overcoming this difficulty - a lighting prescription. Each light also has several preselected modes enabled through direct

Management Team

Project Manager:

- Nancy Zeitlin

Principal Investigator:

- Eirik Holbert

Technology Areas

Primary Technology Area:

Human Health, Life Support & Habitation Systems (TA 6)

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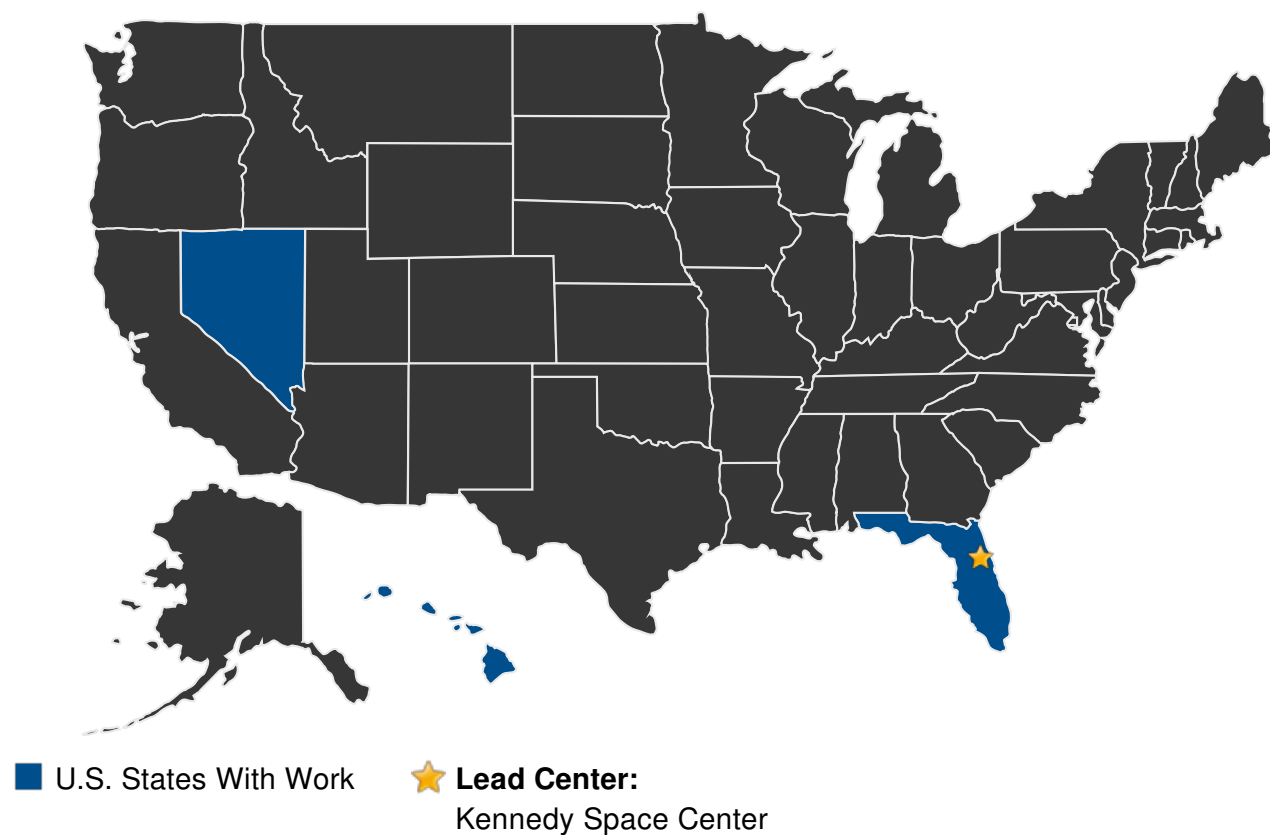
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interaction with the fixture.

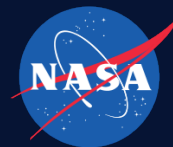
Agreements with the University of Hawaii and Bigelow Aerospace will allow the government to receive feedback on the current algorithms with minimal investment. Hi-SEAS feedback from initial prototype units has already resulted in adjustments to the remote interface design. It is expected feedback from human interaction will result in additional refinements to both the interface, lighting algorithm, and overall assembly.

U.S. LOCATIONS WORKING ON THIS PROJECT



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Other Organizations Performing Work:

- Bigelow Aerospace
- University of Hawaii (Honolulu, HI)

Contributing Partners:

- Bigelow Aerospace
- University of Hawaii
- University of Hawaii

IMAGE GALLERY



Lighting Prototype for the Bigelow BA330 ECLSS simulator

DETAILS FOR TECHNOLOGY 1

Technology Title

Advanced Lighting Algorithm

Technology Description

This technology is categorized as firmware for ground scientific research or analysis

This software simulates within practical limits normal illumination to facilitate crew diurnal cycles. It keeps the fixture dim during the rest periods, warm but moderately bright during recreation periods, and bright and cool during work periods to aid crew concentration. There are gradual transitions between each phase to simulate the motion of the sun across a terrestrial sky.

Capabilities Provided

Provides the capability to maintain a normal circadian adjustment without jarring transitions of brightness or color.

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Potential Applications

This technology is applicable to the sleep disorder community. Potential users could be those who are not exposed to a normal diurnal period including those in medical communities, shift workers, and those near or above the arctic circles.